

Effect of pharmacist-led medication review on drug-related problems among outpatients undergoing elective surgery at a tertiary care hospital: A retrospective study

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ABSTRACT

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Few studies have examined drug-related problems among patients before surgery, including the influence of herbal supplements and dietary products on anaesthetic and surgery outcomes. The primary objective was to measure the prevalence of drug-related problems in outpatients before surgery. The secondary objectives were to investigate the types of herbal supplements and dietary products that might affect anaesthetic and surgical outcomes. Additional aims included exploring factors influencing drug-related problems. This retrospective study was conducted at the preoperative assessment centre. Outpatients aged 18 years or older, who were scheduled for elective surgery, were enrolled. Of 1,440 patients, 27.5% had at least one drug-related problem. The most common category involved medication appropriateness, with herbal supplements and dietary products being the most frequently implicated, particularly among females and those aged 60 years or older ($p < 0.001$). Multivariate analysis also showed a trend towards an increased occurrence of drug-related problems in patients aged 60 years or older. The findings of this study suggest that pharmacist-led medication review in pre-operative patients may be an effective method to reduce surgical risks associated with medications, herbal supplements, and dietary products; prevent surgical postponement; and optimize the management of chronic diseases, particularly in elderly patients.

Keywords: DRPs; drug-related problems; medication review; outpatients; prior surgery

1. INTRODUCTION

When a patient is scheduled for surgery, the anaesthetist evaluates the individual's physical and mental status to identify potential risks and complications. Another essential component of this assessment is a review of the patient's current medications. The anaesthetist advises which medications should be discontinued or continued until the day of surgery. If any drug-related problems

(DRPs) are identified, explanations and recommendations are provided to the patient.

DRPs are defined as any adverse event or circumstance arising from medication use that actually or potentially compromises desired health outcomes (Pharmaceutical Care Network Europe Association, 2020). Such complications can lead to hospitalisation, prolonged hospital stay, or postponement of surgery. An effective method for detecting DRPs is a structured medication

review. This process involves systematically evaluating a patient's medication regimen to optimise use, minimise DRPs, and document any issues and recommendations. Actions are then prioritised according to their urgency and level of risk (Clinical Excellence Commission, 2019).

Literature on drug-related issues (Roshanzamiri et al., 2017) comparing outpatients and inpatients reveals that DRPs occur more frequently among outpatients (20.1%) than among inpatients (8.65%). Among older patients, DRPs are associated with a 30% hospitalisation rate (Haag et al., 2022; Roshanzamiri et al., 2017). This phenomenon often arises from polypharmacy (five or more medications), multiple comorbidities, complex medication regimens, and age-related changes in pharmacokinetics and pharmacodynamics (Haag et al., 2022; Roshanzamiri et al., 2017).

Research from Thailand and elsewhere (de Lorenzo-Pinto et al., 2019; Thummawut & Wongyingsinn, 2024) indicates that DRPs among outpatients are common and can lead to adverse outcomes. Previous studies have reported that a lack of knowledge about managing medications for chronic conditions contributed to surgery cancellations.

Many studies have consistently reported the beneficial role of pharmacy services in improving outcomes among patients with chronic diseases across various healthcare settings; however, no studies have specifically examined the impact of herbal supplements and dietary products on anaesthetic and surgical outcomes. The prevalence of herbal supplements and dietary product use among surgical patients varies by region, with reported rates ranging from 50% to 68% in different countries (Barqawi et al., 2024; Leung et al., 2001; Ozsaker et al., 2024). The incidence of underreported herbal use is high, with many patients not informing anaesthetists, leading to significant perioperative risks. According to a previous study (Ozsaker et al., 2024), up to 90% of patients did not inform anaesthetists about their use of these products prior to surgery, and only 17% were aware of the need to discontinue herbal supplements and dietary products at least two weeks before the surgery.

Herbal supplements and dietary products may interact with anaesthesia and surgical procedures through multiple mechanisms. Potential adverse effects associated with preoperative use of herbal medications can involve multiple organ systems and alterations in drug metabolism (Elvir Lazo et al., 2024). It has been reported that up to 51% of patients used herbal supplements and dietary products within two weeks before surgery. Among these supplements, 30% had direct effects on the cardiovascular system, 27% affected coagulation, and 20% increased sedative effects (Dippenaar, 2015). The recommended duration for discontinuing each supplement was inferred from pharmacokinetic data. The American Society of Anesthesiologists (ASA) does not have formal practice guidelines regarding the discontinuation of herbal supplements and dietary products before surgery, due to limited pharmacokinetic data, variable metabolism, and uncertainty in drug clearance. In the absence of sufficient data, the ASA recommends discontinuing these supplements at least two weeks before surgery (American Society of Anesthesiologists, 2020; Cummings et al., 2021).

The primary objective was to measure the prevalence of DRPs in outpatients before surgery. The secondary objectives were to explore the types of herbal supplements

and dietary products that may affect anaesthesia or surgery outcomes, investigate factors influencing the use of herbal supplements and dietary products, and DRPs.

2. MATERIALS AND METHODS

2.1 Study design

This retrospective, observational study was conducted at the preoperative assessment centre between 1 January 2024 and 30 June 2024.

2.2 Study population

Inclusion criteria

Patients

Outpatients aged 18 years or older were enrolled in this study if they were scheduled for elective surgery through the operating scheduling system program between 1 January and 30 June 2024.

Interventions

All patients received pharmaceutical care in accordance with the standard clinical practice followed by pharmacists at the centre. On the day of the appointment, before evaluation by anaesthetists, each patient met with a pharmacist for a comprehensive medication review. This assessment encompassed prescription and over-the-counter medications, herbal supplements, and dietary products, as well as an evaluation of medication adherence and identification of DRPs.

Exclusion criteria

Patients were excluded if their physical examination was conducted by anaesthetists via telephone without a prior face-to-face evaluation by pharmacists. This exclusion criteria was applied to prevent communication errors and to ensure accurate patient reporting of medications, herbal supplements, and dietary products. This information is often underreported; however, it is essential for assessing perioperative bleeding risk and for planning perioperative management.

2.3 Data collection

Demographic data—comprising sex, age, underlying disease, and details of prescribed medications, herbal supplements, and dietary products—were retrieved from electronic medical records. DRPs were documented as shown in Table 1. The DRP classification was adapted from the drug therapy problem categories of the New England Quality Innovation Network to identify issues of appropriateness, effectiveness, safety, and adherence. The 2021 consensus statements from the Society for Perioperative Assessment and Quality Improvement (SPAQI) were employed to evaluate herbal supplements and dietary products (Cummings et al., 2021). Medication reconciliation forms served as the primary data collection tool.

2.4 Definition of DRPs

We defined four types of DRPs. The first was appropriateness, referring to the use of unnecessary medications or herbal supplements and dietary products without clear indications and drug duplication. The second was effectiveness, referring to improper drug selection and dosage that was too low. The third was safety, referring to dosage that was too high, contraindication, drug allergy, and side effect. The fourth was adherence, defined as

failure to continue any medication as prescribed. We reported DRP data monthly, based on the total number of patient visits during the study period.

Table 1. Demographic characteristics of the study sample (n = 1440)

Characteristics	Frequency (%)
Sex	
Female	805 (55.9)
Male	635 (44.1)
Age, median (IQR)	68 (60–75)
Number of comorbidities	
≥3	737 (51.2)
<3	703 (48.8)
Comorbidities	
Hypertension	942 (65.4)
Type 2 diabetes mellitus	519 (36.0)
Dyslipidaemia	404 (28.1)
Cardiovascular disease	294 (20.4)
Chronic kidney disease	145 (10.1)
Old cerebrovascular accident	138 (9.6)
Anaemia	127 (8.8)
Cancer	118 (8.2)
Respiratory disease	105 (7.3)
Thyroid disease	89 (6.2)
Benign prostatic hyperplasia	78 (5.4)
Others	288 (20.0)
Number of drugs	
≥5	1036 (71.9)
<5	404 (28.1)
Herbal and dietary supplement use	
No	1162 (80.7)
Yes	278 (19.3)

Note: IQR interquartile range

2.5 Performance measures

Two clinical pharmacists were assigned to interview patients about their medication use, review their medications, and identify DRPs. Performance data were collected using the centre's standardised data collection form and included prescribed medications, herbal supplements and dietary products, details of DRPs, and the acceptance rate of pharmacist interventions. The information was subsequently recorded in a Google Sheet. At the end of each working day, another pharmacist rechecked the data to verify the accuracy and completeness of the patient interview records. Both pharmacists received annual training in identifying DRPs from the hospital's department of pharmacy. The classification of DRP types was standardized for data collection and implemented hospital-wide.

2.6 Role of pharmacists in the centre

On the day of the appointment, prior to assessment by the anaesthetist, pharmacists performed a medication review, reviewed all medications, including herbal supplements and dietary products, verified the actual doses taken, and identified DRPs. When DRPs were identified, pharmacists documented their findings in the medical record and provided the interventions to the anaesthetist. For patients using herbal supplements or dietary products that could affect anaesthetic or surgical outcomes, pharmacists

recommended discontinuing these agents two weeks before surgery, in accordance with the guidance from the ASA and the 2021 SPAQI recommendations. Following consultation with the anaesthetist, pharmacists counselled patients on which medications and supplements should be discontinued prior to surgery and provided appropriate instructions. All information was recorded in both the pharmacists' database and the hospital's electronic medical record system.

2.7 Statistical analysis

The sample size was estimated based on data from the 2023 annual performance report at this centre, which indicated the rate of DRPs per month of 16% to 30% among outpatients. In this study (2024), the proportion of DRPs (p) was expected to be approximately 0.16, with a 95% confidence interval (CI) of 0.16 ± 0.02 (error = 0.02, equivalent to 12.5% of p). Using the sample size formula for estimating a single proportion, 1,291 patients were required. To compensate for 10% incomplete data, the final sample size was then 1,440. The centre serves approximately 200–250 patients per month; therefore, the data would be collected during January to June 2024.

Baseline characteristics were summarized using descriptive statistics, including median (IQR) for continuous variables and number (%) for categorical variables. The prevalence and types of DRPs were reported. Data on groups of medications associated with these problems, as well as any herbal supplements and dietary products affecting anaesthetic and surgical outcomes, were also collected. To determine factors associated with the occurrence of DRPs and the use of herbal supplements, the chi-square test was applied for univariable analysis, and multiple binary logistic regression was used for multivariable analysis. Final results were presented as adjusted odds ratios (aORs) with 95% confidence intervals (CIs) and p-values. All statistical analyses were performed using IBM SPSS Version 30 (SPSS Inc., Chicago, IL, USA). A p-value of < 0.05 was considered statistically significant.

2.8 Ethical approval

The Siriraj Institutional Review Board, Faculty of Medicine Siriraj Hospital, Mahidol University, approved the study protocol on 4 October 2024 (reference: Si 783/2024).

3. RESULTS

3.1 Baseline characteristics

Among 1,440 patients who met the inclusion criteria, 55.9% were female. The median age was 68 years (interquartile range 60–75). The most prevalent underlying conditions were hypertension (65.4%), type 2 diabetes mellitus (36.0%), and dyslipidaemia (28.1%). A total of 278 patients used herbal supplements and dietary products, and 152 of these individuals were taking products that posed a risk for anaesthesia and surgery outcomes.

3.2 Prevalence and categories of DRPs

The prevalence of DRPs was 27.5%. A total of 396 patients experienced 423 DRPs (1.1 DRPs per patient). Appropriateness was the most common DRP category (58.2%), followed by adherence (32.2%), safety (8.7%),

and effectiveness (0.9%). These findings are summarized in Table 2.

3.3 Drug groups causing DRPs

Herbal supplements and dietary products made up the largest group of medications leading to DRPs (34.1%). Other groups were antidiabetic drugs (17.7%), cardiovascular drugs (12.6%), anaemia drugs (8.1%), and antiplatelet and anticoagulant drugs (7.4%). Detailed data are presented in Table 2.

3.4 Details of DRPs

Unnecessary herbal supplements and dietary products constituted the most prevalent drug-related problem (35.9%, $n = 152$). The second most frequent issue was intentional deviation from prescriber instructions (24.1%, $n = 102$), including taking higher or lower doses than prescribed, using medications for non-medical purposes, or combining them inappropriately. The third most frequent DRP was untreated indications or the need for additional medication (20.8%, $n = 88$). Details are shown in Table 3.

3.5 Types of herbal supplements and dietary products

According to the findings of this study, among a total of 1,440 patients, 278 (19.3%) reported using herbal supplements and dietary products. Of these, 152 patients (54.7%) were found to be using herbal supplements and dietary products that could potentially affect anaesthetic or surgical outcomes. When categorised by pharmacological properties, 85.5% of the herbal supplements and dietary products exhibited antiplatelet or anticoagulant effects (e.g., karyat, ginkgo, turmeric, vitamin E, and ginger), while 7.2% affected the nervous system, 5.3% had blood pressure-lowering properties, and 2.0% reduced blood glucose levels. These findings are summarised in Table 4.

Table 2. Characteristics of the 423 drug-related problems in the 396 patients

Characteristics	Frequency (%)
Number of DRP events ($n = 396$ patients)	
1	371 (93.7)
2	23 (5.8)
3	2 (0.5)
DRP categories ($n = 423$ problems)	
Appropriateness	246 (58.2)
Adherence	136 (32.2)
Safety	37 (8.7)
Effectiveness	4 (0.9)
Drug groups causing DRPs ($n = 446$)	
Herbal supplements and dietary products	152 (34.1)
Medications	
Antidiabetic drugs	79 (17.7)
Cardiovascular drugs	56 (12.6)
Anaemia drugs	36 (8.1)
Antiplatelet and anticoagulant drugs	33 (7.4)
Lipid-lowering drugs	21 (4.7)
Respiratory drugs	13 (2.9)
Benign prostatic hyperplasia drugs	9 (2.0)
Other drugs	47 (10.5)

Table 3. Details of drug-related problems

Details of DRPs ($n = 423$)	Frequency (%)
Appropriateness	246 (58.2)
Unnecessary herbal supplements and dietary products	152 (35.9)
Untreated indication or need for additional drug	88 (20.8)
Drug duplication	6 (1.4)
Adherence	136 (32.2)
Medication non-adherence	102 (24.1)
Direction not understood	20 (4.7)
Forget to take	12 (2.8)
Cannot afford	2 (0.5)
Safety	37 (8.7)
Side effect	16 (3.8)
Dosage too high	11 (2.6)
Drug interaction	6 (1.4)
Contraindication	3 (0.7)
Monitoring needed for safety	1 (0.2)
Effectiveness	4 (0.9)
Dosage too low	2 (0.5)
Improper drug selection	1 (0.2)
Inappropriate administration	1 (0.2)

Table 4. Number of herbal supplements and dietary products of 152 items

Types of herbal supplements and dietary products	Frequency (%)
Antiplatelet and anticoagulant properties	130 (85.5)
Kariyat	26 (17.1)
Ginkgo	20 (13.2)
Turmeric	19 (12.5)
Vitamin E	17 (11.2)
Ginger	13 (8.6)
Glucosamine	11 (7.2)
Garlic	10 (6.6)
Cordyceps	9 (5.9)
Ginseng	5 (3.3)
Neurological properties	11 (7.2)
Cannabidiol	6 (3.9)
Kratom	5 (3.3)
Blood pressure-lowering properties (Coenzyme Q10)	8 (5.3)
Blood sugar-lowering properties (Bitter melon)	3 (2.0)

3.6 Factors associated with the use of herbal supplements and dietary products

Univariate analysis identified female and age ≥ 60 years as factors associated with the use of herbal supplements and dietary products. In multivariate analysis, the factors significantly related to their use were being female (aOR 1.35, 95% CI 1.03–1.77, p -value = 0.032), being age 60 years or older (aOR 2.16, 95% CI 1.51–3.10, p -value < 0.001), and the number of underlying diseases. However, patients with more than three underlying diseases had 29% reduced odds of the outcome (aOR 0.71, 95% CI 0.54–0.93, p -value = 0.012), suggesting a protective factor. These results are presented in Table 5.

3.7 Factors associated with DRPs

Based on the analysis of four factors, including sex, age, number of underlying diseases, and number of drug items, the univariate analysis showed that only age 60 years or older was significantly associated with the occurrence of drug-related problems (OR 1.34, 95% CI 1.01–1.78, p-value =

0.040). After adjusting for potential confounders in the multivariate analysis, age 60 years or older showed a trend towards an increased likelihood of drug-related problems, although the association was not statistically significant (aOR 1.31, 95% CI 0.98–1.76, p-value = 0.068). The findings are shown in Table 6.

Table 5. Factors associated with the use of herbal supplements and dietary products

Factors	n	Supplements: n (%)		Univariable		Multivariable	
		No (n = 1162)	Yes (n = 278)	p	Crude OR (95% CI)	p	aOR (95% CI)
Sex							
Male	635	528 (83.1)	107 (16.9)	-	1	-	1
Female	805	634 (78.8)	171 (21.2)	0.036*	1.33 (1.02,1.74)	0.032*	1.35 (1.03,1.77)
Age							
<60	345	302 (87.5)	43 (12.5)	-	1	-	1
≥60	1095	860 (78.5)	235 (21.5)	< 0.001*	1.92 (1.35,2.73)	< 0.001*	2.16 (1.51,3.10)
No. of U/D							
<3	703	553 (78.7)	150 (21.3)	-	1	-	1
≥3	737	609 (82.6)	128 (17.4)	0.056	0.78 (0.60,1.01)	0.012*	0.71 (0.54,0.93)

Note: U/D underlying disease

Table 6. Factors associated with the occurrence of drug-related problems

Factors	n	Supplements: n (%)		Univariable		Multivariable	
		No (n = 1044)	Yes (n = 396)	p	Crude OR (95% CI)	p	aOR (95% CI)
Sex							
Male	635	472 (74.3)	163 (25.7)	-	1	-	1
Female	805	572 (71.1)	233 (28.9)	0.167	1.18 (0.93,1.49)	0.118	1.21 (0.95,1.53)
Age							
<60	345	265 (76.8)	80 (23.2)	-	1	-	1
≥60	1095	779 (71.1)	316 (28.9)	0.040*	1.34 (1.01,1.78)	0.068	1.31 (0.98,1.76)
No. of U/D							
<3	703	518 (73.7)	185 (26.3)	-	1	-	1
≥3	737	526 (71.4)	211 (28.6)	0.326	1.12 (0.89,1.42)	0.667	1.06 (0.82,1.36)
Drugs item							
<5	404	304 (75.2)	100 (24.8)	-	1	-	1
≥5	1036	740 (71.4)	296 (28.6)	0.145	1.22 (0.94,1.58)	0.442	1.12 (0.84,1.49)

Several herbal supplements and dietary products are commonly used by patients prior to surgery, which may affect anesthesia and surgical outcomes. In this study, the most frequently used herbal products among patients were karyat (17%), ginkgo (13%), and turmeric (12%). Table 7 provides a summary of these supplements, including their mechanisms of action and recommended preoperative management (Boonsawek et al., 2023; Choi et al., 2020; Cummings et al., 2021; Lau et al., 2009; Marx et al., 2015).

After identifying DRPs for each patient, pharmacists documented their findings in a pharmacist's note within the hospital's electronic medical record. They also provided

interventions to physicians and patient education regarding the use of herbal supplements, dietary products, and medication adherence. The acceptance rate for patient education on herbal supplements, dietary products, and adherence reached 100%. The outcomes of physician interventions showed an overall acceptance rate of 85%, including a total acceptance rate of 75% for DRPs that could be resolved directly at the centre and a partial acceptance rate of 10% for DRPs requiring consultation with the patient's primary physician to adjust therapy. All recommendations and interventions were systematically recorded in the hospital's electronic medical record.

Table 7. Herbal supplements and dietary products, mechanisms, and recommendations

Herbal supplements and dietary products	Mechanisms	Recommendations
Bitter melon	Stimulates insulin secretion and enhances glucose uptake by muscles.	Hold for 2 weeks
Cannabidiol	Delta-9-tetrahydrocannabinol and cannabidiol have been shown to inhibit platelet aggregation in vitro. May also increase anaesthetic requirements.	Discontinue
Cordyceps	Inhibit platelet aggregation by exerting an inhibitory effect on adenosine diphosphate (ADP) and collagen-induced platelet aggregation.	Hold for 2 weeks
Coenzyme Q10	May cause hypotension by increasing nitric oxide (NO) production.	Hold for 2 weeks
Garlic	Inhibits platelet aggregation through cyclooxygenase activity and the reduction of thromboxane A ₂ formation.	Hold for 2 weeks
Ginger	Inhibits platelet aggregation induced by arachidonic acid, epinephrine, ADP, and collagen.	Hold for 2 weeks
Ginkgo	Ginkgolide B is a potent inhibitor of platelet-activating factor (PAF) in vitro.	Hold for 2 weeks
Ginseng	Inhibits platelet aggregation induced by ADP and collagen and exhibits anticoagulant effects by prolonging PT and APTT.	Hold for 2 weeks
Glucosamine	Inhibits platelet aggregation via aspirin-like effects and inhibition of the ADP receptor P2Y ₁ .	Hold 48 hours *due to a more rapid metabolism and shorter elimination half-life.
Kariyat	Inhibit platelet aggregation and enhance NO production, resulting in vasodilation and an increased risk of bleeding.	Hold for 2 weeks
Kratom	Exhibits opioid- and stimulant-like properties; chronic use may lead to neurologic effects, including seizures.	Discontinue
Turmeric	Inhibits platelet aggregation via thromboxane metabolism and calcium channel inhibition and also inhibits the production of thrombin and factor Xa.	Hold for 2 weeks
Vitamin E	inhibiting protein kinase C (PKC) stimulation and potentially exhibits antiplatelet activity.	Hold for 2 weeks

3.8 Prevalence of planned surgical procedures

Among 1,440 patients, 97.5% proceeded with their scheduled surgical procedures. Thirty-six patients (2.5%) did not undergo surgery as planned, most commonly due to an intercurrent illness (55.6%). Medication, particularly antiplatelet and anticoagulant drugs, accounted for 11.1% of all postponements or cancellations. Furthermore, 72.2% of patients who did not proceed with surgery were aged 60 years or older. In contrast, no surgeries were postponed due to DRPs.

4. DISCUSSION

In this study, we found that the prevalence of DRPs was 27.5%. Following multivariate analysis, patients aged 60 years or older showed a trend towards an increased likelihood of experiencing DRPs. This finding is consistent with previous research from Thailand (Tantipiwattanasakul, 2019) and northern Sweden (Peterson & Gustafsson, 2017), which reported higher rates of DRP among older patients.

The highest percentage of DRPs involved unnecessary herbal supplements and dietary products, followed by adherence issues. These findings align with a Swedish study (Wickman et al., 2022), which reported that unnecessary drug therapy was the most frequent DRP category. Similarly, a study among elective surgical patients in Ethiopia (Mohammed et al., 2022) found that

the need for additional drug therapy was the most common DRP, followed by non-compliance.

In our study, 54.7% of patients reported using herbal supplements and dietary products that could affect anaesthetic and surgery outcomes, which is consistent with previous studies reporting a prevalence of 50% to 68% among preoperative patients (Barqawi et al., 2024; Leung et al., 2001; Ozsaker et al., 2024), making these products the most common cause of DRPs. Antiplatelet and anticoagulant properties were the primary contributing factors. The most frequently reported herbal supplements included kariyat, which inhibits platelet aggregation and promotes nitric oxide production, leading to vasodilation and an increased bleeding risk, and is primarily used for COVID-19 prevention; and ginkgo, which inhibits platelet-activating factor and is primarily used to improve memory. Females and those aged 60 years or older were significantly more likely to use herbal supplements and dietary products. Notably, patients with more than three underlying diseases demonstrated lower odds of the outcome, suggesting a protective factor. This finding may be explained by the fact that patients with multiple chronic conditions are already taking numerous prescribed medications, which may reduce their likelihood of using herbal supplements and dietary products. This study found that factors associated with increased use of herbal supplements and dietary products included being female and those aged 60 years or older. This finding is consistent with previous research in Hungary (Soós et al., 2015), which reported that the

majority of surgical patients using herbal medicine were female and predominantly over 60 years of age.

We also observed that the drug groups most frequently linked to DRPs were antidiabetic, cardiovascular, and Anaemia medications. Similarly, studies from general medical wards (Deawjaroen et al., 2022) and stroke units (Semcharoen et al., 2019) in Thailand identified cardiovascular and antihypertensive agents as the most frequent contributors to DRPs.

Adverse events related to herbal supplements and dietary products have been reported in several case reports. For example, a patient who took fish oil and garlic concentrate capsules for three months postoperatively developed ecchymosis and bruising near the surgical site (Bedi et al., 2016). Additionally, another patient experienced a massive haemorrhage following a laparoscopic sleeve gastrectomy for obesity after consuming six cups of freshly prepared homemade ginger for weight loss (Alshimemeri et al., 2024).

Identifying DRPs in patients undergoing elective surgery offers several important clinical benefits. First, it allows for the early detection of potential medication-related risks, which may increase perioperative complications. Second, this approach allows pharmacists to assess patients' use of herbal supplements and dietary products and evaluate their potential impact on anaesthetic and surgery outcomes. Additionally, resolving DRPs enhances patient safety, medication adherence, and education by helping patients understand which medications, herbal supplements, and dietary products should be discontinued or adjusted prior to surgery. Overall, the systematic identification and management of DRPs contribute to improved surgical outcomes, reduced perioperative morbidity, and enhanced coordination among the multidisciplinary team.

In this study, no surgical procedures were postponed due to DRPs. However, some surgeries were postponed because patients did not discontinue antiplatelet or anticoagulant drugs, possibly because they did not remember that these medications needed to be stopped, as no reminder was provided prior to the scheduled surgery. This represents a study limitation.

A key strength of this study is its real-world outpatient setting at a pre-operative patient assessment centre, where a multidisciplinary team cares for patients before surgery. Pharmacists can promptly detect drug-related concerns and consult with anaesthetists whenever necessary.

There are some limitations. This investigation was based on a retrospective chart review, which led to some missing or incomplete patient data. In addition, no comparison was possible between pre- and post-intervention findings because the centre provides only a single pre-operative visit for anaesthesia consultation, without ongoing follow-up care. To prevent undesirable events, future research should focus on developing a pre-operative patient monitoring system (1 to 2 weeks before surgery) that enables early detection and resolution of DRPs, thereby enhancing surgical safety and reducing potential complications.

5. CONCLUSION

DRPs are frequently encountered in outpatient services, with a high prevalence among patients awaiting surgery. The most common category of DRPs involved appropriateness, primarily due to the use of unnecessary

herbal supplements and dietary products. This issue is particularly concerning in preoperative patients, as these products are often self-purchased and consumed without disclosure to physicians or anaesthetists, thereby increasing the risk of adverse outcomes. Another critical concern involves patient adherence, which is essential for the safe and effective management of medications, herbal supplements, and dietary products prior to surgery. Therefore, the identification of DRPs in preoperative patients by pharmacists is beneficial for preventing complications related to medication, herbal supplements, and dietary products; minimising surgical postponements on the day of surgery; and enhancing perioperative safety in both anaesthetic and surgical management. Additionally, it provides patients with accurate knowledge and understanding to support appropriate self-care prior to surgery.

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AUTHOR CONTRIBUTIONS

K.C. developed the research concept, framework, and design of the study, focusing on patients in the preoperative setting. D.A. prepared the initial draft of the manuscript, including the literature review. K.C. and D.A. collected data and performed data processing. K.C. conducted the statistical analysis and interpreted the results. K.C. revised and refined the manuscript based on the initial draft, finalized the content for submission, and managed the journal submission process. K.C. and D.A. contributed to the revised version of the manuscript.

REFERENCES

- Alshimemeri, A., Al-Mishari, H., Shoukry, E., Ali, E., & Metawe, M. (2024). A young adult male with postoperative bleeding following bariatric surgery. *Critical Care and Shock*, 27(3), 141–144.
- American Society of Anesthesiologists. (2020). *Herbal and dietary supplements and anesthesia*. https://madeformthismoment.asahq.org/wp-content/uploads/2020/10/ASA_Supplements-Anesthesia_Updated-1.pdf
- Barqawi, A., Egbaria, A., Omari, A., Abubaji, N., Abushamma, F., Koni, A. A., & Zyoud, S. H. (2024). The use of complementary and alternative medicine among surgical patients: A cross-sectional study. *Perioperative Medicine*, 13(1), Article 110. <https://doi.org/10.1186/s13741-024-00468-7>
- Bedi, H. S., Tewarson, V., & Negi, K. (2016). Bleeding risk of dietary supplements: A hidden nightmare for cardiac surgeons. *Indian Heart Journal*, 68(Suppl. 2), S249–S250. <https://doi.org/10.1016/j.ihj.2016.03.028>
- Boonsawek, B., Supan, W., Sombood, P., & Vichitvejpaisal, P. (2023). Drug interaction of andrographis paniculata



- in anesthesia. *The Journal of Chulabhorn Royal Academy*, 5(1), 35–43.
- Choi, E., Oh, J., & Sung, G.-H. (2020). Antithrombotic and antiplatelet effects of *Cordyceps militaris*. *Mycobiology*, 48(3), 228–232. <https://doi.org/10.1080/12298093.2020.1763115>
- Clinical Excellence Commission. (2019). *A guide to medication reviews for NSW health services 2019*. https://www.cec.health.nsw.gov.au/_data/assets/pdf_file/0016/554110/A-Guide-to-Medication-Reviews-for-NSW-Health-Services-2019.PDF
- Cummings, K. C., Keshock, M., Ganesh, R., Sigmund, A., Kashiwagi, D., Devarajan, J., Grant, P. J., Urman, R. D., & Mauck, K. F. (2021). Preoperative management of surgical patients using dietary supplements: Society for perioperative assessment and quality improvement (SPAQI) consensus statement. *Mayo Clinic Proceedings*, 96(5), 1342–1355. <https://doi.org/10.1016/j.mayocp.2020.08.016>
- de Lorenzo-Pinto, A., Ortega-Navarro, C., Ribed, A., Giménez-Manzorro, Á., Ibáñez-García, S., de Miguel-Guijarro, Á., Ginel-Feito, M. D., Herranz, A., & Sanjurjo-Sáez, M. (2019). Cancellations of elective surgical procedures due to inadequate management of chronic medications. *Journal of Clinical Pharmacy and Therapeutics*, 44(4), 561–564. <https://doi.org/10.1111/jcpt.12816>
- Deawjaroen, K., Sillabutra, J., Poolsup, N., Stewart, D., & Suksomboon, N. (2022). Characteristics of drug-related problems and pharmacist's interventions in hospitalized patients in Thailand: A prospective observational study. *Scientific Reports*, 12, Article 17107. <https://doi.org/10.1038/s41598-022-21515-7>
- Dippenaar, J. M. (2015). Herbal and alternative medicine: The impact on anesthesia. *Southern African Journal of Anaesthesia and Analgesia*, 21(1), 8–13. <https://doi.org/10.1080/22201181.2015.1013321>
- Elvir Lazo, O. L., White, P. F., Lee, C., Cruz Eng, H., Matin, J. M., Lin, C., Del Cid, F., & Yumul, R. (2024). Use of herbal medication in the perioperative period: Potential adverse drug interactions. *Journal of Clinical Anesthesia*, 95, Article 111473. <https://doi.org/10.1016/j.jclinane.2024.111473>
- Haag, J. D., Bellamkonda, V. R., Perinpam, L., Peters, B. J., Sunga, K. L., Gross, C. L., Dierkhising, R. A., Baudoin, M. R., & Rudis, M. I. (2022). Prevalence and categorization of drug-related problems in the emergency department. *The Journal of Emergency Medicine*, 63(2), 192–199. <https://doi.org/10.1016/j.jemermed.2022.04.016>
- Lau, A.-J., Toh, D.-F., Chua, T.-K., Pang, Y.-K., Woo, S.-O., & Koh, H.-L. (2009). Antiplatelet and anticoagulant effects of *Panax notoginseng*: Comparison of raw and steamed *Panax notoginseng* with *Panax ginseng* and *Panax quinquefolium*. *Journal of Ethnopharmacology*, 125(3), 380–386. <https://doi.org/10.1016/j.jep.2009.07.038>
- Leung, J. M., Dzankic, S., Manku, K., & Yuan, S. (2001). The prevalence and predictors of the use of alternative medicine in presurgical patients in five California hospitals. *Anesthesia & Analgesia*, 93(4), 1062–1068. <https://doi.org/10.1097/00000539-200110000-00053>
- Marx, W., McKavanagh, D., McCarthy, A. L., Bird, R., Ried, K., Chan, A., & Isenring, L. (2015). The effect of ginger (*Zingiber officinale*) on platelet aggregation: A systematic literature review. *PLoS ONE*, 10(10), Article e0141119. <https://doi.org/10.1371/journal.pone.0141119>
- Mohammed, M., Bayissa, B., Getachew, M., & Adem, F. (2022). Drug-related problems and determinants among elective surgical patients: A prospective observational study. *SAGE Open Medicine*, 10, 1–10. <https://doi.org/10.1177/20503121221122438>
- Ozsaker, E., Cengiz, H., & Pursal, M. (2024). Investigation of herbal products used by patients before surgery. *Progress in Health Sciences*, 14(1), 7–14. <https://doi.org/10.5604/01.3001.0054.6291>
- Peterson, C., & Gustafsson, M. (2017). Characterisation of drug-related problems and associated factors at a clinical pharmacist service-naïve hospital in Northern Sweden. *Drugs - Real World Outcomes*, 4(2), 97–107. <https://doi.org/10.1007/s40801-017-0108-7>
- Pharmaceutical Care Network Europe Association. (2020). *PCNE classification for drug-related problems V9.1*. https://www.pcne.org/upload/files/417_PCNE_classification_V9-1_final.pdf
- Roshanzamiri, S., Farrokhian, A., & Eslami, K. (2017). Incidence of drug related problems in outpatient setting: A review article. *Journal of Pharmaceutical Care*, 5(3–4), 76–78.
- Semcharoen, K., Supornpun, S., Nathisuwan, S., & Kongwatcharapong, J. (2019). Characteristic of drug-related problems and pharmacists' interventions in a stroke unit in Thailand. *International Journal of Clinical Pharmacy*, 41(4), 880–887. <https://doi.org/10.1007/s11096-019-00832-4>
- Soós, S. Á., Jeszenői, N., Darvas, K., & Harsányi, L. (2015). Herbal medicine use by surgery patients in Hungary: A descriptive study. *BMC Complementary and Alternative Medicine*, 15, Article 358. <https://doi.org/10.1186/s12906-015-0890-2>
- Tantiapiwattanasakul, K. (2019). The influence of patient factors on medication adherence in ambulatory care unit at Bangplama hospital, Suphanburi. *Journal of Health Science*, 28(1), S107–S119. [in Thai]
- Thummawut, W., & Wongyingsinn, M. (2024). Rate and cause analysis of surgical case cancellation related to medications in a university hospital. *Thai Journal of Pharmacy Practice*, 16(1), 283–294. [in Thai]
- Wickman, K., Dobszai, A., Modig, S., Borgström Bolmsjö, B., Caleres, G., & Lenander, C. (2022). Pharmacist-led medication reviews in primary healthcare for adult community-dwelling patients – a descriptive study charting a new target group. *BMC Primary Care*, 23(1), Article 237. <https://doi.org/10.1186/s12875-022-01849-x>